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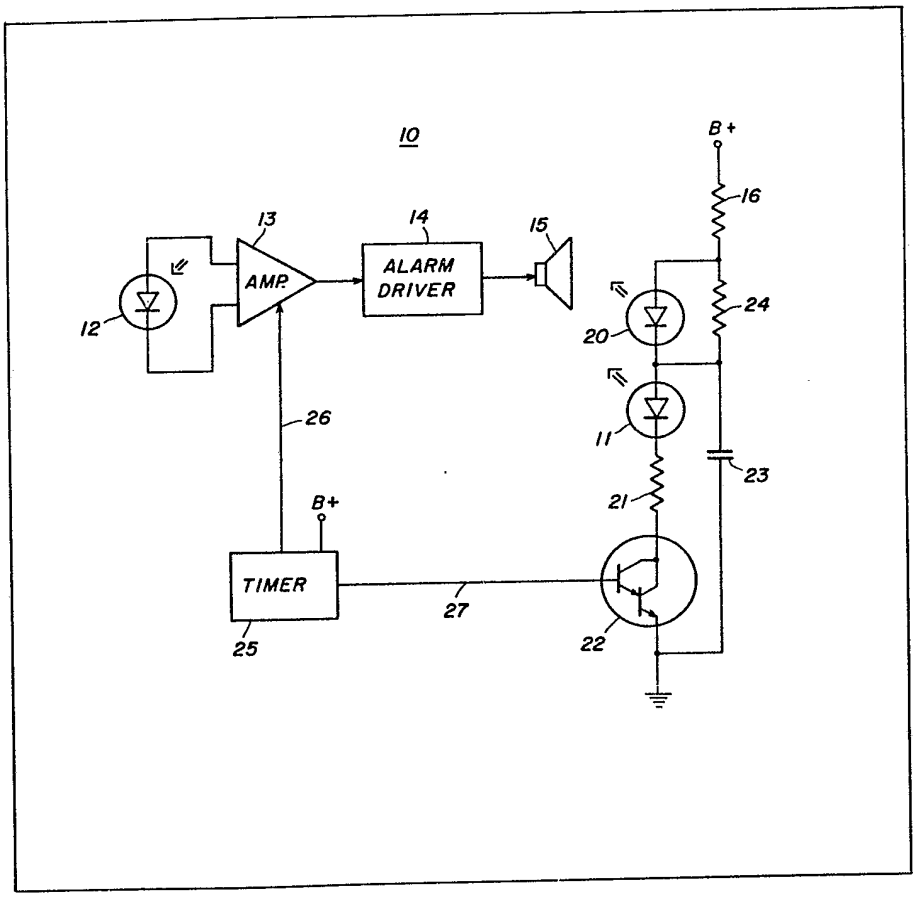
(54) Combustion products detector

(57) A combustion products detector, such as a smoke detector, of the type utilising photo-electric detection of light from a light source 11 which is scattered by the, e.g., smoke particles, has the light source 11 connected in series with a transistor switch 22 across a power supply B+. Light from the light source 11 which is scattered by the smoke particles is detected by a photodiode 12 to operate an audible alarm 15. The transistor switch 22 is intermittently rendered conductive by a timer 25, and a capacitor 23 in parallel with the light source 11 and the transistor switch 22, is charged when the transistor switch 22 is non-conductive and discharges through the light source 11 to energise the light source 11 when the transistor switch 22 is conductive. A light emitting diode 20 connected in series with the capacitor 23 in the capacitor charging circuit is energised each time the capacitor 23 is charged to give a visual indication, the frequency of which indicates whether a fault exists in the capacitor discharge circuit and the nature of the fault.



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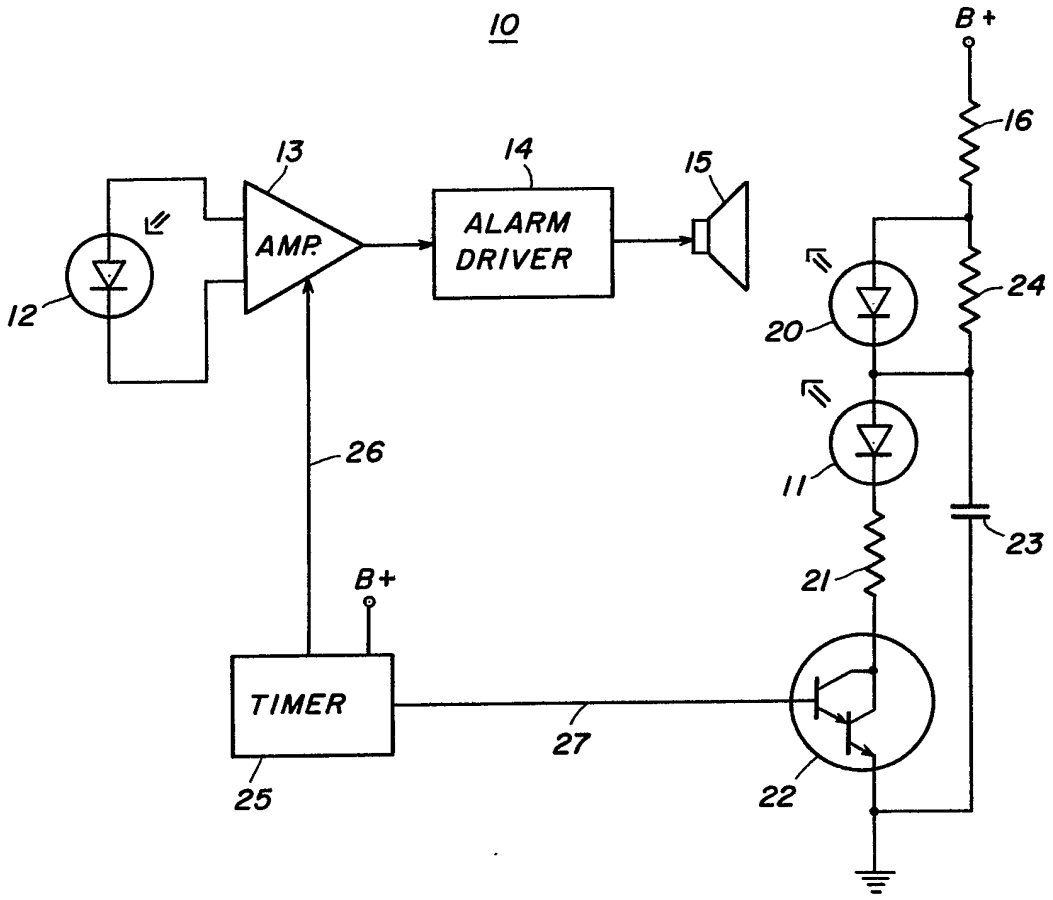
10
B+
16
13
14
15
AMP.
ALARM
DRIVER
12
20
24
11
26
23
21
B+
TIMER
27
25
22

SPECIFICATION

Combustion products detector

This invention relates to combustion products detectors such as smoke detectors working on the principle of interference of light by smoke particles between a light source and a photo-responsive sensor for producing an alarm signal. More particularly, the invention relates to circuitry for indicating the existence of a fault or other trouble in the smoke detector circuitry.

Smoke detectors of this type typically include an oscillator or other timing device for controlling the periodic energisation of the light source to conserve energy. Typically, light from the source is confined within a smoke chamber so that the light is not visible outside the smoke detector unit. Indeed, many such smoke detectors utilize an infra-red light source, which would be invisible to human eyes even if the light were directed outside the unit. Thus, there is no way to tell from observation of the unit whether or not the circuitry therein is operating properly. In particular, there is no way to tell whether the light source itself or the timing circuitry which controls its energisation are operating normally.

Circuits for indicating faults in the light source circuitry or a smoke detector are known, such as that disclosed in US patent no. 4,025,915 but the alarm indicating a fault in the described system is indistinguishable from the smoke alarm and the system is incapable of detecting faults other than those in the light emitting diode forming the light source. Other known forms of system make use of auxiliary light emitting diodes to provide indications of faults in the primary smoke detecting circuitry. However, these systems indicate only specific faults and moreover the auxiliary light emitting diodes are connected in circuits parallel to the primary light sources, so that they draw additional current which in a battery powered system increases current drain on the battery and adversely affects battery life.

According to the invention a combustion products detector including a light source, photoelectric means responsive to light from the source scattered by particles of combustion products to produce an alarm output and timing means periodically actuating the light source means also includes a fault detecting arrangement comprising indicating means connected in series with the light source and responsive to each operation thereof for producing an indication of the operation without drawing any current beyond that required by the light source. Preferably the timing means operates to periodically close switching means and a capacitor is connected in parallel with the light source and the switching means so as to be charged by the power supply when the switching means is open and to be discharged through the light source and the switching means when the switching means is closed to energise the light source and the indicating means is connected in series with the power supply and the capacitor so as to be energised when the capacitor is being charged to produce an output indication.

Not only does this economise in current but the fault indicating circuitry may give an indication different in character from the alarm signal, e.g. it may be visual.

The invention will now be described with reference to the accompanying drawing which is a schematic diagram of a smoke detector incorporating fault indicating circuitry in accordance with the present invention.

A simplified smoke detector, generally designated as 10, is of the type which utilises the reception of light scattered from smoke particles to produce an alarm signal. The light source is a light-emitting diode (LED) 11, which is typically of the type which emits infra-red light. the light beam from the LED 11 is directed through a smoke chamber (not shown) toward a receiver which comprises a photodiode 12, the terminals of which are connected to the input terminals of an amplifier 13. The output of the amplifier 13 is connected to the input of an alarm driver circuit 14, the output of which is connected to an annunciator such as a horn 15.

In operation, ambient smoke particles will infiltrate the smoke chamber and will there scatter the light beam from the LED 11 on to the photodiode 12 for generating therein an electric current which is then amplified by the amplifier 13 to a level suitable for energising the alarm driver circuit 14 to drive the horn 15 to produce an audible alarm signal of predetermined duration indicating the presence of smoke, all in a well-known manner.

The LED 11 is powered from a DC supply such as a storage battery (not shown) the positive terminal of which is designated B+. More particularly, the anode of the LED 11 is connected to the cathode of an LED 20 which produces a visible light beam, and the anode of which is connected through a resistor 16 to B+ supply. The cathode of the LED 11 is connected through a resistor 21 to the collector of a transistor, such as a Darlington transistor 22, the output emitter of which is grounded. A capacitor 23 is connected from the anode of the LED 11 to ground and a resistor 24 is connected in parallel with the LED 20. A timer circuit 25 is provided with the B+ supply voltage and produces a first output signal which is applied via conductor 26 to a gain control terminal of the amplifier 13, and a second output signal which is applied via conductor 27 to the base of the Darlington transistor 22.

Preferably, the timer circuit 25 produces output signals having a duration of approximately 30 to 40 ms simultaneously on the conductors 26 and 27 at intervals of about 20 seconds. The output of the amplifier 13 is effectively blocked except in the presence of one of these brief timing signals on the conductor 26, and the Darlington transistor 22 is normally non-conductive and is rendered conductive every 20 seconds by the timing signals on the conductor 27.

In normal operation, between timing signals the

Darlington transistor 22 is non-conductive and the LED 11 is de-energised. However, current from the power supply flows through the resistor 16 and the LED 20 rapidly to charge the capacitor 23. At the end of the 20 second interval, the timing signal on the conductor 27 renders the Darlington transistor 22 briefly conductive for rapidly discharging the capacitor 23 through the LED 11, the resistor 21 and the transistor 22, thereby energising the LED 11 and producing therefrom an infra-red light pulse. If smoke is present in the smoke chamber during this light pulse, the light will be scattered to the photodiode 12 for producing an input signal to the amplifier 13 which is simultaneously activated by the timing signal on the conductor 26. The output signal from the amplifier 13 energises the alarm driver circuit 14 for driving the horn 15 for a predetermined time, determined by the circuitry of the alarm driver circuit 14.

At the end of the 30 to 40 ms timing signal, the transistor 22 is again rendered non-conductive and the capacitor 23 again charges through the LED 20. During normal operation, this cycle will be repeated indefinitely. It will be noted that the value of the resistor 16 is such that the capacitor 23 will be charged rapidly, producing a relatively short pulse of light from the LED 20 at 20 second intervals, immediately after each discharge of the capacitor 23. Therefore, a pulsing of the LED 20 at 20 second intervals is a positive indication that the capacitive discharge circuitry, including the LED 11, the transistor 22 and the timer circuit 25 are operating properly.

If the LED 11, the transistor 22 or the timer circuit 25 become open-circuited, the capacitor 23 cannot discharge. Thus, once the capacitor 23 is charged, the LED 20 will not be energised again. Accordingly, the absence of a light pulse from the LED 20 after a 20 second interval is an indication of an open circuit condition in the capacitive discharge circuitry.

If the capacitor 23 or the transistor 22 were short circuited or otherwise improperly conductive, then the visible LED 20 would be on constantly, giving a positive indication of the short circuit condition. Thus it will be appreciated that either short circuit or open circuit conditions in any of several different components in the capacitive discharge circuitry can be positively indicated by the fault indicating circuitry of the present invention. Also it will be appreciated that since the LED 20 is connected in series with the capacitor 23 during the charging thereof, and is connected in series with the LED 11 if the capacitor 23 is short circuited, the fault indicating LED 20 draws no more current than that which is normally required for re-charge of the capacitor 23 and the resulting energisation of the smoke detecting LED 11. The resistor 24 provides an alternative charging path for the capacitor 23. Thus even if the LED 20 were to become open circuited, the smoke detecting circuitry would still operate.

In a constructional model of the illustrated circuit the resistor 16 is rated at 220 ohms, 1/4 watt, the resistor 21 is rated at 3.9 ohms, 1/2 watt and the resistor 24 is rated at 68K ohms, 1/4 watt. The capacitor 23 has a capacitance of 10 microfarads. While a simplified form of smoke detector 10 has been described, for purposes of illustration, it will be appreciated that the smoke detector could also include circuitry for indicating low battery voltage, and circuitry could be provided for alternating the timing sequence in the presence of smoke, all in a well known manner.

From the foregoing, it can be seen that the smoke detector includes fault indicating circuitry which provides a positive indication of different types of faults in the smoke detecting circuitry, this fault indication being of a different character than the smoke detection alarm signal and causing no additional current drain on the power supply.

CLAIMS

1. A combustion products detector including a light source, photoelectric means responsive to light from the source scattered by particles of combustion products to produce an alarm output and timing means periodically actuating the light source means and also including a fault detecting arrangement comprising indicating means connected in series with the light source and responsive to each operation thereof for producing an indication of the operation without drawing any current beyond that required by the light source.

2. A detector according to claim 1 wherein the indicating means produces a visual indication.

3. A detector according to claim 1 wherein the indicating means is a light source.

4. A detector according to claim 3 wherein the indicating means is a visible light emitting diode.

5. A combustion products detector including a light source and switching means connected in series across a power supply, timing means for periodically closing the switching means and photo-electric means responsive to light from the source scattered by combustion products particles to produce an alarm output and in which a capacitor is connected in parallel with the light source and the switching means so as to be charged by the power supply when the switching means is open and to be discharged through the light source and the switching means when the switching means is closed to energise the light source and indicating means is connected in series with the power supply and the capacitor so as to be energised when the capacitor is being charged to produce an output indication.

6. A detector according to claim 5, wherein the indicating means produces a visual indication.

7. A detector according to claim 6 wherein the indicating means is a light source.

8. A detector according to claim 7 wherein the indicating means is a visual light emitting diode.

9. A detector according to any one of claims 5 to 8 in which an impedance is connected in parallel with the indicating means to provide a charging circuit for the capacitor if the indicating

means is open circuited.

10. A detector according to any one of claims 5 to 9 in which an impedance means is connected in series with the indicating means to limit the current therethrough and determine the charging rate of the capacitor.

11. A combustion products detector including a fault detecting arrangement substantially as described and as illustrated with reference to the accompanying drawing.

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